Dairy Biological Risk Management

March 2005

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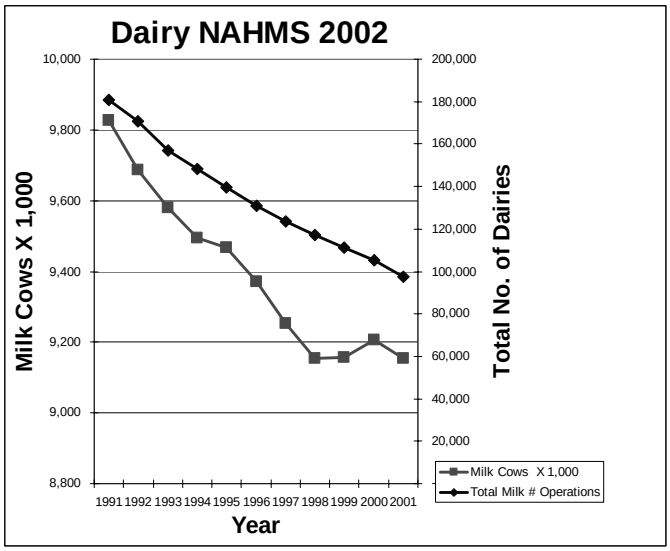
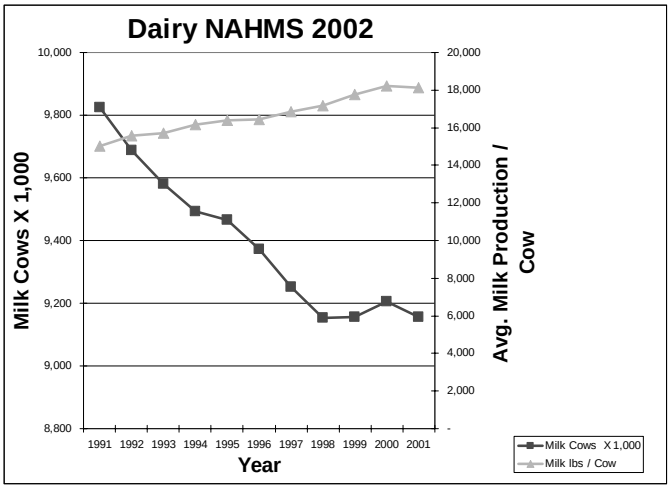
Introduction

The dairy cattle industry has undergone dramatic changes in the last two decades. Some of these changes have included declining operation numbers, increasing herd sizes, an increase of milk production per cow, and farm specialization. While farms continue to get larger, there are still a considerable number of small to medium sized dairies that continue to raise their own heifers and feedstuffs while producing quality milk. This variation in economic base and production style does not end with the number of cattle raised on farm. When designing a biological risk management plan for dairies, one size does not fit all, and we will discuss how to assess different farming operations later in this paper.

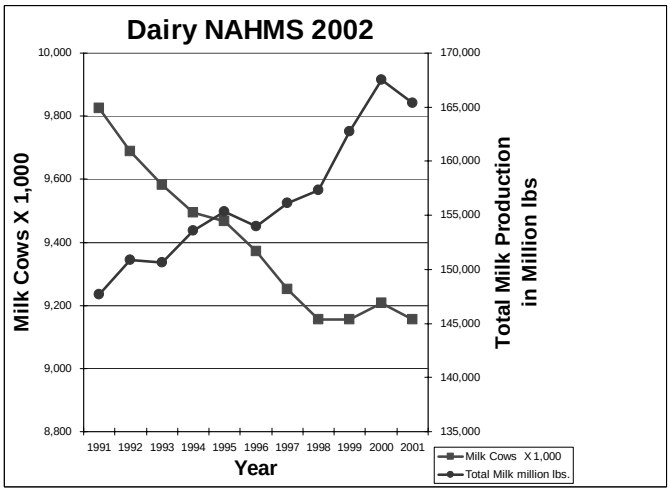
The following three graphs from the Dairy National Animal Health Monitoring System (NAHMS) study of 2002 enables us to identify the direction the industry has taken over the past several years. The graphs are from 1991-2001 and indicate a decline in operation numbers, but also indicate the number of animals and the average milk production per cow are increasing. These trends within the United States dairy industry directly impact the design of biological risk management plans and a breach could have more costly consequences.



Total Number of Dairies indicates the total number of cows in the U.S. has decreased from about 9.83 million to 9.16 million. At the same time, the total number of dairies has decreased from 180,640 to 97,560 operations. This amounts to a 46% decrease in dairy operations accompanied by only a 6.8% decrease in milk cow inventories during these 10 years.



Average Milk Production/Cow shows that while total cow inventories have decreased, the average pounds of milk produced per cow increased from 15,031 to 18,138. That is a 20.7% increase in productivity.



Total Milk Production demonstrates the combined effect of less cows (6.8%) accompanied by an increase in productivity (20.7%) resulting in a total U.S. milk production going from 147,697 million pounds of milk in 1991 to 165,336 million pounds in 2001. This is a net increase of 11.9% of milk being produced.

Importance of Dairy BRM

The dairy industry prides itself in producing a wholesome, safe product. Milk supplies 73% of the calcium to the U.S. food supply which is vital to the health of children, growing young adults and the elderly. Using the NAHMS 2001 total milk production of 165 billion pounds of milk, this would translate into a total of 19.8 billion gallons of milk which can be made into 16.5 billion pounds of cheese, 7.8 billion pounds of butter, or 13.8 billion gallons of ice cream!

As people move farther away from the farm and their food source, dairy producers have to become better promoters of their quality product, in ways never thought of before. Petting zoos and visitor days are becoming more common across the U.S. to give children and their families a better sense of what dairy production is all about. While it is a great idea and builds a sense of understanding among consumers, it is not without risk.

To illustrate this point, let us look at an outbreak of *Escherichia coli* O157:H7 infections among visitors to a dairy farm in Pennsylvania. This dairy farm had 216 head of cattle, of which 40 were adult cows. The farm was often visited by the public, especially groups of children, to see

and pet the animals. In September 2000, there were 15 confirmed and 36 probable cases of *E. coli* O157:H7 in people who had recently visited this farm. A majority of the cases (92%) were in children under 10 years of age. Fortunately no children died, but one child developed end-stage renal failure and required a kidney transplant. A comprehensive epidemiological investigation identified 33 of the 216 cattle at this dairy (15%) were colonized with *E. coli* O157:H7. This high rate of colonization was thought to indicate a recent exposure of the herd to *E. coli* O157:H7.

However, this farm environment can be made safer for visitors with some basic hygiene principles. Strategies include:

- The use of hand washing, including stations accessible to young visitors,
- Controlled and supervised contact with animals, and
- Clear separation of food-related activities from those areas housing animals.

These are the concepts surrounding biologic risk management. Simple steps can be taken that have minimal expense to achieve the desired goal of a biologically safer environment for both animals and people.

Interesting to note, no residents or employees of the farm reported having diarrhea during the outbreak period. Past exposure could have provided immunity to those working at the farm and their ability to stay healthy was not necessarily due to lack of exposure. The zoonotic implication of this outbreak also demonstrates the importance of biologic risk management. Could one of the employees or owners at this Pennsylvania farm (or the farm you are actually visiting), possibly have carried this *E. coli* O157:H7 home and exposed one of their children to this organism? What if it were salmonellosis? Increasing awareness to the potential risks helps everyone prepare for the unexpected.

BRM provides an excellent opportunity to evaluate and act upon ways to continue to safeguard the dairy industry and the people working within it against diseases. The information provided in this material is to help you establish a comfort level in evaluating biological risk management for your clients. Evaluation of different operations will highlight the strengths as well as the weaknesses for each of them.

Risk Perception

The category of risk perception examines what those involved with the operation think about the real and potential risks of infectious and zoonotic diseases. These perceptions may be influenced by what has been encountered on the farm in the past, or by what owners, managers, and employees may have read in magazines, on the internet, or in the paper.

This is also the period where one may encounter many of the obstacles and challenges to educating about risk management. Many individuals have negative perceptions associated with risk management, most of which are based around ideas of disbelief or economic concerns. Common negative beliefs include:

- I already know this stuff
- We have always done it this way

- I've already had most everything on this farm
- I don't have enough time to mess with this
- It's too complicated
- It won't make any difference
- It's too expensive
- I don't have the space
- Our animals were tested once and we found nothing, it was just a waste of money
- Our farm is pretty safe

Disease risk cannot be totally eliminated, but attention paid to biological risk management can reduce risks and their consequences. While it is difficult to prove and measure the benefit of things that **don't** happen, counter-arguments tend to fall into three categories: there is a risk, it is economically worthwhile to prepare, and the overall impact must be considered.

- Infectious/zoonotic disease outbreaks can and do happen as the *E. coli* example above illustrated.
- Prevention is always less costly than treatment.
- Protecting your financial investment and your future assets from liability is worthwhile insurance.
- Protecting employees saves time and money.
- A biological risk management plan established and followed will help manage the threat of foreign animal disease entry and spread.
- A focus on preventative medicine helps to maximize public and environmental health of your community.
- Prevention of disease through awareness and management of infectious disease risk is an important part of decreasing the potential for antibiotic resistance and its consequences.

Risk Assessment

To increase its effectiveness and completeness, a comprehensive risk assessment should be performed from a variety of perspectives. First and foremost, the general herd characteristics and farm policies should be examined through a pre-assessment questionnaire (see Pre-Farm Questionnaire in handouts).

In reviewing this material, it is imperative to understand that the focus is on routes of transmission, not specific disease entities. Assessing risk based on route of transmission provides a more complete and holistic approach and avoids emphasizing specific disease(s). The only references made to specific diseases, syndromes or infectious agents in this material are for illustrative purposes only, and there are no specific recommendations provided as to vaccination, treatment or testing procedures. This focus will make the information applicable to a variety of audiences and remain relevant even as scientific advances improve our understanding of diseases.

Risk Management

The documents illustrate the best available "standard operating procedures" for a wide range of management practices. Each veterinarian should perform a thorough assessment to identify opportunities for improvement. Then the management suggestions should be considered as to which ones are most practical, applicable, and economically feasible. Most recommendations can be implemented independent of others. This will result in tailoring the BRM program for each producer based upon his/her preferences, resources, risk perception and risk tolerance. Some suggestions may not be feasible for a given facility; but recognizing what is optimum helps establish long term goals.

Herd Characteristics

Lactating Cows

This is the primary animal species on any given dairy. They can be housed in a variety of ways, each with its own strengths and weaknesses in regards to disease risk.

Confinement facilities- often consist of a free stall building with 2, 3, 4, or 6 rows of stalls in the barn where the cattle are housed and generally remain inside all day every day. There is one stall per animal or per 1.2 animals depending on the facility. Stalls should be bedded with a material that does not enhance organism growth. The stalls should be groomed to remove manure and urine buildup at every milking and fresh bedding added frequently. The feed alley is commonly in the center or along one side of the building and there are large openings along the sides and ends for ventilation and traffic flow. There are automatic trough waterers in each of the large pens that provide water to the cattle in the pen. Cattle generally travel down covered alleys to the milking parlor; there may be additional automatic water troughs in the return lane(s). The primary flooring surface is concrete, but rubber belting is being used more in traffic areas and near the feed bunk. Manure can be removed by manually scraping the stalls, and using a skid steer with a blade/rubber tire to scrape the manure lengthwise down the alleys to a grate system with augers to move it outside to a collection area or manure storage. A recently adopted method of removal is through the use of vacuum trucks or implements. There are also automatic scrapers that run on a pulley system and scrape manure to the end of the alleys multiple times a day. Finally, there are water flush systems that use gravity flow to wash the excrement down the length of the barn into an underground storage system multiple times a day. These facilities can be used to house thousands of cows.

Dry lot facilities- often consist of multiple dirt lots with shade structures for the cattle to escape the sun and weather; more often used in warmer climates. The feed bunks are located on the edges of the dirt lots. Protective covers over the feeders may be present to shelter the cows while they eat and to keep the feed dry when it rains. There are automatic water troughs or wells scattered throughout the dirt lots. The milking parlor is a covered structure, generally centrally located to all the lots, so the cattle are moved through the lots and up dirt alleyways to be milked. There may be automatic water troughs in the return lane(s). The lots are groomed one to multiple times per day using a tractor and drag system. Manure is spread out so that the sun can dry it. Depending on weather conditions and animal density, lots will be scraped so that the top layer of dirt and excrement is removed. Manure storage options vary. These farms can be used to house thousands of animals.

Rotational grazing- this consists of multiple grass and forage-based pastures in which the cows spend their time in between milkings. There may or may not be a feed bunk in the pasture depending on the quality of the grasses and the need for supplemental feeding. Watering sources vary within this production method. There may be a natural stream in the pasture, automatic waterers may be set up near the fence lines, well water may be the primary source, or multiple livestock tanks that require manual filling multiple times per day. Cattle are moved to a covered milking parlor through other pastures or dirt paths. Fencing is usually a series of high tensile wire, not permanent, so that it can be moved based on the growth patterns of the grasses. This method is used throughout the United States, but in northern climates it can only be utilized 4-5 months of the year. Manure is allowed to remain in the pastures as a fertilizer and often the sun dries it out. These facilities are typically used for farms less than 500 cows.

Tie stall/stanchion facilities- this consists of a covered barn, often with solid walls and individual stalls for each of the cows. A tether system is used to confine each cow to her stall; either the cow wears a collar around her neck and is chained to the front of the stall or there is a movable head catch at the front of the stall that restrains the cow around her neck. There is one stall per animal. Stalls should be bedded with a material that does not enhance organism growth. The stalls should be groomed to remove manure and urine buildup at every milking and fresh bedding added frequently. Manure is manually scraped from the back of the stalls into a conveyer at the back end of the stall. It is then automatically moved to the end of the barn where it can be piled on a cement lot or directly into a manure spreader. There are individual feeding areas, or mangers, in front of every cow and a drinking fountain at every stall or every other stall. Cattle remain in their stalls for milking and the equipment is brought to them. There is an overhead pipeline that the milking units connect to so the milk can be moved via gravity to the bulk tank in the milk room. During good weather, cattle are often turned out into a dirt lot, cement or pasture area. Centralized feed bunks, covered or uncovered, and automatic water troughs are generally located in an area near the barn where the cows can be fed during warmer times of the year. These facilities are typically used for farms less than 150 cows.

Milking Procedures

One of the diseases dairy producers deal with on a regular basis is mastitis. The process of milking cows, when done properly, poses very little risk to developing disease. However, there are so many variables involved in milking and it is difficult to ensure that proper procedures are always followed. For these reasons, mastitis will continue to occur. We need to focus on minimizing that risk.

The mechanical variable, the milking unit itself, should be monitored to make sure the vacuum levels are correct, pulsators are working correctly, and the liners are changed on a set schedule depending on their composition, use and wear. Automatic take-offs set appropriately for removal at the end of milking. These are critical steps to make sure the teat end does not experience unnecessary vacuum pressure or massage that induces damage. There are various recommendations available from the National Mastitis Council, various universities and extension, as well as equipment manufacturers. System checks should be done at least yearly, more often if problems are noted. If the teat end is healthy (smooth, soft), it functions as a natural barrier to pathogen entry into the mammary gland. Dry, cracked, and hyperkeratotic teat ends have less of a natural barrier and more potential for pathogens to enter. Research looked at teat-end integrity and those with cracked teat-ends had higher odds of developing a new intramammary infection (IMI) than those without cracks- 15% and 10% (Dingwell RT, et al

2004). While faulty mechanics of the milking equipment are often to blame, teat end damage can result from changes in weather conditions (cold, wind, chapping, frostbite), inappropriate teat dips, damage from other cows (sucking, stepped on) bedding type, and physiological differences in teat ends.

The human variable, the people/person milking the cows, is another consideration when conducting risk assessments to make sure proper procedure is followed time after time. Cows are creatures of habit and so should be the milking process. Studies that looked at complete lactation showed a 5.5% increase in lactational yield when a standardized milking procedure was used. (Rasmussen, Frimer 1990) Experts have reviewed the physiology behind milk let down and a fairly common procedure has been recommended to maximize the milk out process (details will be discussed later). To minimize disease risk during milking, milkers should wear disposable gloves. This will help protect their hands from any organisms that may be on the udder or in the milk and protect the teat end from any organisms that may be on that person's hands. To minimize over-milking of the teat end and subsequent damage, proper stimulation is needed for milk let down. It is important to milk a clean, dry teat to minimize bacteria in the milk and in the milking unit.

The order of milking cows is an important consideration when minimizing disease transmission. First lactation cows should be first, older cows with low somatic cell counts (SCC) next, then those with higher SCC, and finally, clinical mastitis cases. This reduces cow-to-cow transmission of organisms by milking the most susceptible, least resistant animals first when the equipment is the cleanest.

Step one- forestripping. This step allows physical stimulation of the teat and udder to help the cow "let down" her milk. From a disease standpoint, which is the focus of this paper, forestripping allows identification of abnormalities in the fore-milk. Forestripping has been shown to decrease the risk of *Listeria monocytogenes* contamination in the milk by 2.5 times (Midwest Dairy Business 2004). Not every facility practices forestripping, and many complain of the extra time it takes to do so. Studies vary in their results as to whether or not this step in the milking process lengthens or reduces milk-out time. This step should be evaluated for effectiveness at each facility because factors such as a cow's days in milk, breed, udder cleanliness, total udder preparation time, and teat-end integrity affect the successfulness of this step in regards to milk out time. It should be noted that forestripping often precedes cleaning the teat ends. Cows with a lot of organic debris on their teat ends will benefit from a cleaning step first in order to prevent pathogens from entering the teat end once the teat canal is opened with forestripping. The reason for forestripping before cleaning is so that once the teat end is cleaned and dry; the milking unit can be attached. Some will pre-dip (see below), forestrip, then wipe, which is also an accepted process. The key to disease prevention is to limit bacterial uptake into the teat canal.

Step two- cleaning the teat ends. This can be done in a dry prep or pre-dipping manner, each with inherent disease risks and benefits. Dry prep involves manually wiping the teats with a dry towel or dry gloved hand to remove some of the organic debris and to stimulate the cow to let down her milk, depending on contact time. While this is less expensive due to no purchase costs of product, this is not the best way to clean teats prior to milking. According to a study at Cornell, cows that underwent no teat preparation, dry wiping or wetting/washing the udder and appeared to have visibly clean teats still had 3-16 times more bacteria in their milk as compared to cows that were properly prepped. (Galton, DM, et al 1986 and Galton, DM, et al 1988).

Properly prepped teats also resulted in fewer infections. Cornell and Vermont studies demonstrated that pre-dipping reduced new mastitis infections 43-51% more than just washing and drying teats. (Pankey JW, et al 1987 and Galton, DM et al 1988)

Proper teat preparation involves pre-dipping the teats with a disinfectant solution approved for use in dairy cattle. It is important that the pre-dip achieve full coverage of all sides of all teats, allowing it to have 15-20 seconds of contact time to effectively kill the bacteria and then manually drying with a paper or cloth single use towel. Preferably pre-dip should be applied using a dip container versus application with a sprayer. If there is a concern for environmental mastitis pathogens being on the teat skin, contact time may need to be increased to 30 seconds to effectively kill the bacteria.

Step three- wiping the teat. It is important to remove the disinfectant completely and dry the teat before attaching the milking unit. This will prevent residue from entering the milk supply and minimize liner slippage on a wet teat. There are various different wipes on the market. Some are all-in-one disinfectants, others are paper disposable towels, and there are washable cloths that can be used. It is important that producers select what product works best for his/her facility based on the types of pathogens commonly found in your mastitis cases. Disposable towels used once have little risk of disease spread if handled properly (used once and disposed of without handling it in your hands before touching another cow). Washable cloth towels work well but should be laundered with detergent and/or bleach and completely dried on a hot temperature setting after every use. Wet towels can harbor bacteria so the drying process is vitally important to limit disease spread between milkings and cows. An all-in-one disinfectant towel has good efficacy if used properly, but it is essential the teat end is dry before the milking unit is attached to minimize slipping and subsequent teat end damage. Air drying is not always adequate after using pre-moistened towels. Again, individual farm assessment must be done to select the best pre-dipping and wiping method.

All pre-dips and post-dips are not created equal and are not currently regulated by the Food and Drug Administration. It is important to understand that pre-dips focus their bactericidal activity on environmental pathogens, whereas post-dips function to kill contagious pathogens. The National Mastitis Council (NMC) originally established a series of standardized tests that allow manufacturers to evaluate pre- and post-dipping products on a voluntary basis in the 1970's. The products are tested under field and laboratory conditions and rated based on efficacy. The NMC recently reviewed their recommended protocols and revised them to reflect new technologies, enhance the scientific merit of testing, and to further standardize testing procedures. What was formerly known as Protocol A, B and C products are now based on experimental exposure to mastitis pathogens, efficacy based on reduction of new infections, and comparing known efficacy products to new products based on infection rate. They are also to only be used as the testing indicated- as a pre-dip or a post-dip.

Step four- attaching the milking unit. It is recommended that to achieve maximum milk let down and flow that milking units be attached within 60-90 seconds after first touching the cows teat, either by forestripping, pre-dipping or wiping. Regardless of the time factor, the focus should be to milk clean, dry teats that are ready to be milked so that over milking does not occur before full let down. This is good management to prevent pathogen entry into the teat end. Monitor the milking unit for liner slips throughout milking. These can occur at any time but occur most often near the end of milking, which can cause tiny droplets of milk to be propelled back into the teat end. If there are pathogens in this milk and milk flow is slowing

down, the bacteria could enter the udder and not be flushed out, predisposing the cow to infection.

Step five- removing the milking unit. The vacuum should always be shut off prior to removing the milking unit so that liner slip is minimized and so are new infections. Facilities with automatic take-offs should have them set for a minimum output before removing the unit. An udder should not be milked completely dry because it could be more predisposed to pathogen entry and infection.

Step six- post-dipping the cows. After milking, the lower third of the teat should be dipped in a teat antiseptic to minimize the risk of contagious organisms entering the teat. Effective post-dips destroy organisms on teats and prevent teat canal colonization. The herd veterinarian can help decide the product best suited to the types of organisms on the dairy facility. An excellent resource is the "Summary of Peer-reviewed publications on efficacy of pre-milking and post-milking teat disinfectants published since 1980" which was last updated in January 2004. (See Teat Dip Summary) In cold weather, when temperatures drop below 10^{o}F or if wind chill is a concern, the protocol should be altered slightly. Dip the teats; allow contact for 30 seconds, then wipe off excess liquid with a single use paper or cloth towel to minimize frost bite and teat end damage.

During milking, the teat sphincter opens and closes 60 times a minute and it takes 30-45 minutes for it to close with a keratin plug after milking. It is a good management practice to keep cows on their feet during this time so that they do not lie down in a contaminated area and allow organisms to enter the teat before the keratin plug is formed. Offering fresh feed so that it is available after milking will encourage cows to go to the feed bunk and water trough instead of laying down right away, helping that natural barrier protect the mammary gland from infection.

Hospital Pens and Facilities

Some dairies have a dedicated treatment and confinement area for lactating cows. The use of these hospital or recovery areas facilitates re-treatment and provides isolation and protection from violative milk residues. Cattle remain in these areas until they cure infection and/or clear violative milk residues. The treatment area and dedicated instruments easily serve as fomites since they are dedicated to handling the ill and injured animals. Cleaning and disinfection of facilities and instruments should occur after each procedure in an effort to control the spread of disease agents.

The hospital area is designed to provide a place to manage illnesses and injuries and to allow recovery, which can present special disease risks. Often they become a location to house the chronically ill and dying, or become a point source for new infections such as *Salmonella* or *Mycoplasma* mastitis. All animals that enter a hospital pen should be considered new entries into the herd when they return to their home pen. They should be made to pass entry procedures such as an obligatory milk culture (such as *Mycoplasma* and *Staphylococcus aureus*) before entry. A strategy that has been employed to control disease risk in the hospital area is to create pens dedicated to specific entities such as *S. aureus* or *Mycoplasma* spp mastitis, lameness and other disease conditions.

The movement of animals to the hospital pen could be minimized through the use of non-violative therapeutic agents. Conversely, when treatment with a therapeutic agent that causes residues is required, it should be performed as soon as possible, at full dose and duration, and the cow should be moved. Movement forces resocialization when cows enter the hospital area and again when they return to their home pen. Resocialization can create immunosuppressive stress through reduced dry matter intake and animal to animal bullying. Combine this stress to the immunosuppression of the disease process itself and it becomes a significant biological risk factor. The hospital pen should be cleaned or scraped and bedded deeply with dry material to minimize stress. The cleaning equipment should be cleaned and sanitized prior to use in the rest of the herd.

An additional risk for the hospital area is the lack of a clear definition for this area. If recently fresh animals are moved to this area to facilitate treatment and monitoring, a risk exists due to immune system depression approximately two days prior to calving and up to ten days after. Recently freshened cows should not be housed with potentially infectious animals.

Dry Cows

There are different ways to group and house non-lactating cows, again each with it strengths and weaknesses. Dry cows can be split up into those that are far-off or just ending their lactation cycle, and those that are pre-fresh or due to calve within 3 weeks. Each has different nutrient needs but they are similar in their disease risk and so will be discussed together.

Cows that were recently dried off should be moved to an area that is clean and dry so that organisms are not able to enter the teat end, as the sphincter is not tightly closed and the keratin plug does not form for several days to weeks after the final milking. In some cows, the teats remained open until six weeks after dry off (23% of all cows according to research by Dingwell RT, et al, 2004; Also in this study of 300 cows, 11% of quarters developed a new IMI in the dry period). This makes them vulnerable to pathogen introduction and subsequent mastitis post-calving. Depending on the amount of milk production at dry off, udders may become swollen due to milk filling the mammary glands. Initially, milk may leak from the teat ends, so an absorbent, clean bedding material (straw, kiln-dried sawdust, paper) or one that allows drainage (sand, pasture) should be provided for the cows to lie on, again, so that pathogens are not able to enter the teat canal.

As cows approach calving, they should be fed appropriately, so that the colostrum is of optimal quality for the newborn calf, and housed in a clean, dry environment. First calf heifers, depending on their size, may need to be housed separately from pre-fresh cows. Besides the risk of disease transmission between different ages of animals, competition and dry matter intake differences may dictate separate pens and rations for these two groups of animals. Fresh feed specially formulated for their energy, protein, vitamin, and mineral needs and clean water should be made available at all times, again to maximize colostrum quality and ensure a healthy calf.

Calving Pens

Calving pens should be well bedded, clean, draft-free, dry and free of fecal matter build up. Ideally upon fetal presentation, each cow or heifer should have their own calving pen so that organisms are not passed between animals (fecal, oral, fomite, aerosol or direct contact) or to their newborn calves. Prior to colostrum collection, the cows and heifers should have their udder and teats washed with warm water and a mild detergent soap to remove feces and

debris. Depending on the hair growth of the cow or heifer, clipping or singeing excess hair from the udder may also be warranted if proper restraint is available. Making sure the udder and teats are as clean as possible ensures that the colostrum can be removed without fecal or environmental contamination. This limits oral and direct contact disease transmission.

Following calving, the pen is then cleaned for the next individual. Deep straw bedding (1-2 feet) helps drain away the birthing materials (amniotic fluid, placenta, and blood) and animal excrement. Deep bedding will also inhibit the newborn calf from standing and wandering around the pen, trying to nurse on everything. One teaspoon of feces has enough *E. coli*, Johne's, etc bacteria in it to establish infection in a naïve animal.

The calving pen should be monitored every two hours and the newborn calves removed promptly after birth and placed individually in a clean, dry, draft free area. Depending on the degree of environmental contamination of the calving area, the navel could be dipped in a 7% tincture of iodine solution to facilitate drying of the umbilicus to minimize pathogen entry into the abdomen of the calf. Colostrum collected from its dam should be fed within 6 hours after birth and calves should receive >5% of their body weight. Large breed calves should receive ¾ to 1 gallon in the first 6 hours after birth, and another ½ gallon at 12 hour intervals for the first two days of life. Colostrum pasteurization is becoming more common in an effort to control the spread of coliform pathogens, *Mycoplasma* and Johne's disease. Extra care is needed to prevent the coagulation of the product and excessive loss of maternal immunoglobulins. If the calf will not nurse, esophageal feeders can be used. This equipment should be thoroughly washed with warm soapy water, rinsed, then disinfected and hung up to dry between uses. A plastic garbage bag could be thrown over it to protect it from environmental contamination from flies or feces.

Replacement Animals

In general, replacement heifers and bulls should be housed away from adult cattle and in spaces that are suited to their age, size, feed intake, and reproductive needs. There are five distinct groups of heifers: pre-weaning (0-2 months), weaned (3-8 months), pre-breeding (9-12 months), bred (13-22 months), and pre-fresh (23-24 months). Bull calves are typically sold at an early age, pre-weaning, or just after weaning unless they are kept as breeding stock. However, the information below applies to bull calves in regards to disease management.

Pre-Weaned

Young calves, pre-weaning, should be housed individually to minimize the risk of disease spread and to facilitate identification of illness. Calves should have free access to fresh water throughout the day and a calf starter should be made available by 3 days of age. Quality milk replacer or pasteurized whole milk should be offered twice a day to ensure adequate nutrition and growth. If milk is pasteurized, time and temperature of the batch should be monitored on a frequent basis to ensure proper destruction of organisms from the lactating cows. Pasteurized milk is an inexpensive source of feed for young calves if done properly. It can become the most expensive commodity on the farm if it is not properly pasteurized and organisms are allowed to infect the young calf.

Young calves are susceptible to a wide variety of diseases, many of which are zoonotic (*E. coli*, salmonellosis, cryptosporidiosis, leptosporosis, and rabies), so proper personal protective equipment such as gloves, coveralls, and boots, should be worn when feeding and handling neonatal calves.

Pre-weaned calves are the most susceptible age group on the farm and should be fed/handled before the older animals to minimize pathogen introduction. If this is not possible, proper disinfection needs to occur before preparing their milk and feeding them. Hands should be thoroughly washed and disposable gloves worn if possible. Coveralls or clothing and foot wear should be clean; free of organic matter (feces, urine, saliva, milk) from other animals. Even if you are just putting milk bottles into holders you should be clean from head to toe. Just when you do not plan to have to handle the animals, one may be reluctant to stand and drink or have an illness that needs to be investigated further. Due to the activity of young calves and their suckle reflex, minimal contamination on the feeder's clothes will expose the calf to disease causing organisms. It is important to plan ahead before dealing with this susceptible group. Even within the group of calves, working with the youngest animals first can help decrease the risk of disease spread. Milk bottles used to feed these animals should be removed after nursing and the nipples and bottle rinsed with water to remove all organic material, washed in warm water (150^{o}F) with mild detergent, rinsed, inverted and allowed to dry completely before the next feeding. Sanitization of the bottles may be necessary in an outbreak situation. Similar to the esophageal feeder, these clean bottles and nipples should be kept free from environmental contamination in between uses. Milk is an excellent nutrient source for bacterial and viral organisms and if calves are fed in buckets, the buckets should be rinsed after all the milk is consumed to remove the residue. It is good management to rinse each bucket and refill it with fresh, clean water until the next milk feeding. Similar recommendations apply to grain, as it can serve as a breeding ground for both bacteria and insects.

If the calf pen or hutch has solid walls, this will decrease the chance of direct and oral contact with another calf, decreasing the chance of disease spread. If hutches or pens are located outside, adequate shade and ventilation is necessary to avoid overheating and dehydration of the calf. Hutches have the additional benefit of minimizing the concentration of respiratory pathogens. If the calf is allowed to exit the hutch, it is essential to avoid direct contact with other calves or animals to minimize disease spread. This can be accomplished by fencing or tethers that prevent access of calves to one another or their excrement. Calf pens or hutches must be cleaned, sanitized and disinfected between introductions of new calves to minimize disease spread. The ground underneath the calf hutch has the potential to harbor pathogens; organic bedding should be removed and the ground/concrete/gravel remaining idle with sunlight exposure. Time of idleness will depend on the organism; bacterial, viral or protozoal pathogens differ in their environmental survivability, but two weeks is common. Some are able to be killed in dry environments rather quickly (BVD); others persist for longer times (cryptosporidium). Weather conditions and seasonality will affect the persistence of the organism. It is essential to determine the neonatal calf disease threat(s) and design protocols for calf hutch/pen management that targets the pathogen(s). Vaccination should not be a substitute or crutch for good hygiene practices. The "solution to pollution is dilution" and producers should be reminded of that in regards to this susceptible neonatal calf.

If calves are housed in pens with open sides, age cohorts become essential to minimizing disease spread. The risk of direct and aerosol disease spread is higher in this situation, so the area should be filled for a period of two weeks or less and then no additional animals added. This is based on the incubation period of the typical disease organisms that affect the neonatal calf. Longer than two weeks increases the susceptibility of the newly introduced animals to the pathogens in the environment. The same protocols for feeding apply here, but disease spread is a little more difficult to control due to aerosolization of pathogens.

It is at this life stage (less than 10 weeks) that calves should have their horn buds removed. Restraint is easier at this stage and the procedure, when done correctly, has minimal pain effects on the calf. Dehorning can be done with chemical treatments (calcium chloride injections and caustic sticks) and electrical dehorners, with the goal of interrupting blood flow to the developing horn. Cordless, electrical dehorners can be used at 1-3 weeks of age and take less than 10 seconds of application time if done properly. There is no blood to attract flies and institute larval development and subsequent disease as is the case in older animals during dehorning.

Heifer calves should have their supernumerary teats removed at this age as well. Again, restraint is easier and when done correctly, has minimal pain effects. The udder area should be clean, free of debris, and scrubbed with a surgical scrub prior to removal. During removal, gently pull the extra teat away from the udder and cut at an angle from the calf's head to tail with a pair of sterilized surgical scissors. The scissors should be cleaned and disinfected after each use to minimize the risk of infection or disease transmission. Spray the wound with iodine or another antiseptic and be prepared to cauterize or tie off any blood vessels; although bleeding is generally minimal at this age.

Weaned

Once calves are weaned and moved into group housing, considerations should be given regarding animal and group size, and health status of the animal. This is a stressful time for animals due to change in social structure, feeding and housing. First groupings of animals should be up to 6 head and given plenty of space; 25-30 sq ft per head is recommended (MWPS 2000). This will help them adjust socially to their new environment, feeding and watering style. Less stress means less cortisol release leading to a stronger immune system that is better able to deal with commingling; all very important concepts in disease management. As animals adjust to their new environment, group sizes can be increased. While not scientifically proven, it has been suggested increasing group in increments of two's will help improve the social structure of pen mates and reduce stress; the "buddy system" per se.

Proper ventilation, without drafts, is essential to keep aerosolized pathogens from accumulating. Clean, dry bedding, shade, fresh feed and water are still essential to keep the calves' immune system functional so that it is able to fight disease challenges.

Feed and watering will change to a group setting rather than individual buckets. The same basic hygiene principles apply here as above. These animals should be fed before older animals and equipment used to deliver their feed should be clean; free of organic matter (feces, urine, saliva, milk) from other animals. Waterers have a greater potential of contamination with multiple animals in the same enclosed area, so they should be monitored daily for functionality and cleaned weekly or whenever organic debris begins to accumulate.

Vaccinations are essential at this time because maternal antibody has waned and the calf could be exposed to novel pathogens in a group setting. Establishing a protocol with the herd veterinarian based on endemic diseases, future breeding and transportation needs are essential to help develop a healthy heifer.

Pre-Breeding

The same basic hygiene principles regarding feeding and watering apply here as above. These animals should be fed before older animals, but after bred heifers. (Bred heifers have a higher risk of disease exposure due to their pregnancy status and the risk of BVD persistently infected animals, for example). Equipment used to deliver their feed should be clean; free of organic matter (feces, urine, saliva, milk) from other animals. Waterers have a greater potential of contamination with multiple animals in the same enclosed area, so they should be monitored daily for functionality and cleaned weekly or whenever organic debris begins to accumulate.

This group of animals will need to be vaccinated and boostered for the diseases that can be a challenge during pregnancy, so their immune system is ready to adjust to carrying a calf for nine months.

Disease risks associated with breeding vary depending on the type of reproductive service used. In natural service, it is essential that the herd bull(s) have a breeding soundness exam that includes motility testing and staining, palpation of the seminal vesicles, testes and examination of the penis for abnormalities. A full range of herd vaccinations 30 days prior to entry, and diagnostic procedures for both venereal and systemic disease pathogens, including BVD, according to the herd veterinarian's recommendations are good management techniques to minimize disease introduction by the herd bull(s). When using artificial insemination, acquire semen from a reputable source that tests their bulls for venereal diseases and screens for genetic abnormalities. Upon insemination, basic hygiene principles apply. Hands should be thoroughly washed and disposable gloves worn if possible. Coveralls or clothing and foot wear should be clean; free of organic matter (feces, urine, saliva, milk) from other animals so that the pipette does not get contaminated. There are specific management protocols relating to semen straw storage and thawing, but in regards to disease management, keeping the pipette clean is essential to minimize pathogen entry into the vagina. All barriers (gloves, rectal sleeves) should be disposed of after inseminating each animal, again to minimize cross-contamination. Similar precautions should be taken when collecting and transplanting embryos.

Bred

Due to their pregnancy status, this group of animals is more susceptible to disease than the pre-breeding animals, even though they are older. Due to the in-utero calf, their immune system is compromised, so every effort must be made to limit their disease exposure. Not only is the bred heifer less able to fend off infection, she carries a naïve calf that could succumb and abort, become a stillborn, a weak calf or congenitally infected. In a ranking process, they would be considered more at risk for disease than pre-breeding animals yet not as susceptible as pre-weaning or weaned calves.

The same basic hygiene principles regarding feeding and watering apply here as above. These animals should be fed before older animals and before pre-breeding animals due to the different "at risk" conditions. Equipment used to deliver their feed would preferably be designated for feed usage only; otherwise it should be thoroughly cleaned and disinfected; free of organic matter (feces, urine, saliva, milk) from other animals. This rule also applies to the equipment that assists in the production of rations such as skid steers and front end loaders. Waterers have a greater potential of contamination with multiple animals in the same enclosed area, so they should be monitored daily for functionality and cleaned weekly or whenever organic debris begins to accumulate.

Animals should be monitored daily for signs of illness and/or abortion. If an animal should abort, promptly remove her and her fetus along with all other birthing material. Based on the risk of zoonotic diseases causing abortion in cattle (brucellosis, leptospirosis, listeriosis, salmonellosis), proper personal protective equipment especially gloves, should be worn when handling the fetus and parturient material and fluids. The area should be cleaned and disinfected to minimize the risk of an infectious agent exposing other bred animals. Heifers should be isolated from other animals and minimally exposed to older, lactating cows. The fetus, depending on the state of degradation, may need to be promptly submitted for diagnostics, based on the recommendations of the herd veterinarian. The cow/heifer may or may not come into her milk, depending on the stage of her gestation when she aborted. If she is to be milked, she should be treated as an isolation case; milked last and minimize contact with other animals. Ideally she should be housed alone without direct contact to other cows/heifers. Housing her with hospital cows could predispose her and others to continual infection, depending on what the abortion resulted from (infectious versus genetic/toxic ingestion).

Pre-Fresh

Within 3-4 weeks of their projected due date, heifers/cows should be moved to an area where they can be monitored multiple times a day. Their nutrient needs are changing, as is their dry matter intake. They should be fed on a plane of nutrition targeted to their needs and the needs of that near-term calf in order to produce high quality colostrum. Grouping heifers with multiparous cows raises a few concerns, although most facilities are not set up to do it any other way. Things to consider in regards to housing related disease risk are:

Are the heifers from the same source as the adult cattle? If so, then they are not considered "newly introduced". However, if they are recently purchased or returning from a professional heifer grower, then isolation to prevent disease introduction would be necessary for the heifer, her unborn calf and the pregnant multiparous cows on the home facility. See section on newly introduced animals for recommendations to prevent disease entry and spread.

What is the social difference between a heifer and cow? Heifers are typically submissive to older individuals. Movement into group housing with mature cows will result in time spent establishing social dominance. This can cause immunosuppressive stress through animal to animal bullying and reduced dry matter intake. This can predispose them to disease during this crucial pre-fresh period.

What is the prevalence of various diseases in the source adult herd? If the farm has an eradication plan in place for specific cattle diseases, the risk is too high to group pre-fresh heifers with multiparous cows. There are certain diseases in adult cattle that can be easily spread through excrement to newborn calves. If a heifer calves before being moved to a clean maternity area, that neonatal calf is now in a high risk area for disease exposure. Endemic disease prevalence is an item that the herd veterinarian has the expertise to manage. If there are no diseases of concern, which is rare on most dairy operations, home raised heifers should be at relatively low risk for pathogen spread from the adult animals.

The same basic hygiene principles regarding feeding and watering apply here as above. These animals should be fed before older animals due to their susceptibility to disease. Equipment used to deliver their feed should be clean; free of organic matter (feces, urine, saliva, milk) from other animals. Waterers have a greater potential of contamination with multiple animals

in the same enclosed area, so they should be monitored daily for functionality and cleaned weekly or whenever organic debris begins to accumulate.

Animals should be monitored daily for signs of illness and/or abortion. Once again if an animal should abort, promptly remove her and her fetus along with all other birthing material. Proper personal protective equipment, especially gloves, should be worn when handling the fetus and parturient materials and fluids, again due to the risk of zoonotic disease. The same information stated above in bred animals applies here, although heifers often come into their milk at this stage of gestation and should be milked as an isolation case.

These animals should be housed in a pen where they can be monitored frequently throughout the day. Manure management is essential as animals could calve in this area and disease exposure to the newborn calf must be minimized. Once signs of calving are present, heifers/cows should be moved to an individual calving pen that is clean, dry, and draft free. See "maternity pen" section for specific recommendations.

New Introductions

The most certain way to prevent introducing a new disease would be to prevent introducing new animals to the herd. This is not feasible for many dairy facilities, so accepted risk practices need to be established. Biological risk of transmission of pathogens such as *S. aureus*, *M. bovis, Mycobacterium avium paratuberculosis*, BVDV and *Salmonella* spp. can be minimized by limiting the frequency and number of new introductions as much as possible.

Purchases should be limited to a minimal number of sources, preferably with a known and trusted herd health program. A complete herd health history should be obtained prior to introducing new animals if at all possible. It is not unreasonable to request copies of bulk tank samples, somatic cell count, DHIA reports, and vaccinations, illness and treatments records of purchased animals. Dairy producers need to establish the level of disease risk they are willing to accept and the level of biosecurity they are willing to pay for.

Testing for diseases of interest should be considered as well. Many additional factors should be evaluated in this decision, including the risk of disease introduction by this animal, potential consequences associated with disease introduction, how the disease is transmitted, and whether there are other effective ways to manage or control the disease (vaccination or treatment, for example). Characteristics of the test should also be considered, such as sensitivity, specificity, cost, convenience and potential risks associated with testing, and time required obtaining meaningful results. Results must always be interpreted in light of other evidence. A positive test result should always be of concern and could justify additional testing (for more definitive diagnosis) or termination of the sale. A negative test result does not guarantee freedom from disease and should not be accepted as the sole determinant of risk. The test sensitivity, clinical appearance of the animal, history, and status of the herd of origin must all be used to provide meaning to a negative test result and limit the risk posed by a newly introduced animal.

There are inherent risks associated with purchasing animals of various ages. This should be recognized and used to guide purchase decisions. For example, purchasing young animals has a greater risk of introducing calf hood diseases such as scours and respiratory diseases. Animals that have mated previously could introduce reproductive diseases. Older animals are

also more likely to have contracted chronic or latent infections, particularly those that are not restricted to being acquired during calf hood. Susceptibility and/or clinical signs can also change with age. However, older animals that have developed a tolerance to a disease may not show clinical signs but could be a carrier. These issues should be considered when deciding on testing protocols and what age group of animals to purchase.

It is recommended that animals that are newly acquired or reintroduced after an absence be quarantined for a minimum of 21 days, some recommend 30 to 45 days. This will allow adequate time for clinical signs to develop if the animal is incubating an acute infection. However, chronic or latent infections may not show symptoms for years, if ever. An additional benefit of isolation is to allow sufficient time to obtain negative test results if pre-entry testing procedures are performed. The isolation facility should be capable of preventing contact with **all** other animals including those in the destination farm as well as those in neighboring operations and wildlife. The isolation must protect from all of the potential routes of transmission, and receive the same BRM scrutiny as all other areas of the operation. The isolation area should be cleaned and disinfected and ideally sit empty for some time between uses.

When introducing animals, doing so in groups that can be housed, fed, milked last and treated together will help spread out the costs of the special handling. People are more apt to follow protocols for a whole group of animals rather than one animal that can get lost in the shuffle. Continual introductions to an established group of animals results in social stress and repeated exposure to new pathogens. Purchasers should vaccinate newly acquired animals, utilizing a program that matches the home herd to the greatest extent possible (read and follow the recommendations of the vaccine manufacturer). Preferably this should occur prior to delivery on the premises.

Animals Returning to the Farm

Movement of animals on and off a dairy operation can introduce disease. Therefore, animal traffic should be limited to the minimum amount necessary. Delivery/load-out areas should be located at the perimeter of the property and should be cleaned and disinfected thoroughly after new cattle arrive. All trucks and trailers used to transport animals should be cleaned and disinfected inside and out after each use because they often travel to areas where pathogens are abundant in the environment. Accumulation of manure, feed and bedding is a perfect medium for organism survival and multiplication.

When animals are taken off of the operation and then return (fairs, shows, veterinary clinic, and embryo transfer facilities) they should be handled as a new introduction. Additional measures should also be taken during their time away to limit their contact with other animals. This includes prohibiting sharing of trailers, stalls, feed or water with animals from other operations. Other items to consider include: halters and lead ropes, grooming supplies, feed and water containers, reproductive equipment (artificial vaginas for semen collection, artificial insemination pipettes, uterine pipettes, etc.), needles and syringes, among others. These items should not be shared; otherwise they need to be properly cleaned and sterilized between animals. Diligent efforts should be made to prevent fecal contamination of feed, water or the immediate environment by other animals. Direct contact with other animals should be minimized and reproductive activity should be prohibited. People contact should also be minimized. If at a fair or show do not allow the public to feed your animals.

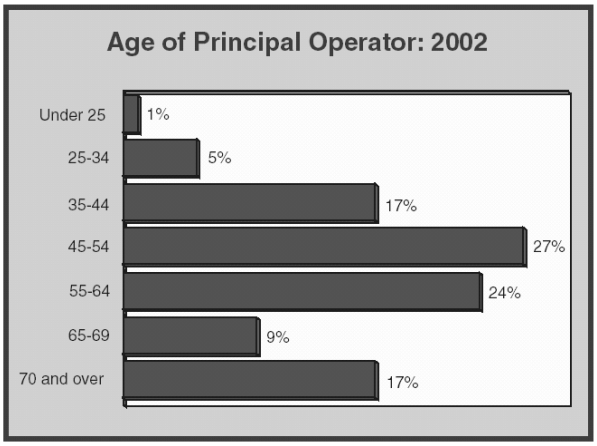
Human Traffic on the Dairy Farm

Foot traffic also poses a significant risk of pathogen introduction and spread on a dairy facility (such as *S. aureus, Mycobacterium avium paratuberculosis* (Johne's), BVD and *Salmonella* spp.). People walking through a farm include employees, neighboring property owners, sales and service personnel, veterinarians, hunters, hikers and other visitors. In order to keep track of who comes and goes, anyone who does not live on the facility should be required to sign a visitor's log book and instructed on what areas are acceptable or unacceptable for foot traffic. Restricted areas need to have clearly posted signs so as to remind visitors not to enter. It is important to ask visitors about prior contact with animals on other operations, and ask those at high risk of transmitting disease to take additional precautions (shower in and change clothes or return at another time). Regardless, restricted areas should be delineated and animal contact should be minimized.

Producers should also consider requiring all visitors to wear clean coveralls and overboots. Providing clean coveralls for visitors will cover any "outside" organic debris on the visitors clothing and provide a barrier to disease introduction. The coveralls will also allow all organic material that is obtained on the farm during the visit to remain on that farm and prevent carrying it to another facility or into the home of the visitor. This can help protect the visitor and their family against potential zoonotic diseases. Disposable plastic overboots can be provided rather inexpensively (less than $1.00 per pair) and provide the additional benefit of protecting visitors shoes from manure and soil/mud; again a potential zoonotic disease concern alleviated. Another option is to provide a foot bath at the main entrance with a requirement that all visitors disinfect their footwear. However, there are limitations to the effectiveness of human foot baths. All gross debris must be cleaned off first and the disinfectant solution must be used under appropriate conditions (proper concentration, proper temperature, free of organic debris, frequent maintenance, etc.). A footbath that does not meet these conditions may in fact create a false sense of security while providing little or no protection.

Zoonotic Disease and Health Concerns of Employees

The chart below is from the 2002 Census of Agriculture and shows the distribution of the ages of the principal operator on today's farms.



The average age of today's farmer is 55.3. As people age, their reflexes and immune systems decline. They aren't as able to react to a fractious animal or recover from injury or illness. Considerations need to be made for those older, as well as the very young, at risk individuals. While there is no definition of what categorizes a person as older or elderly, it is known that the immune system does not function as efficiently in older adults as it does in younger people. The body becomes less able to fight infection and the central nervous system becomes less sensitive to immune signals, making the immune system function less efficiently. For example, more than 20% of

adults over age 65 that had a serious bacterial infection lacked a fever response (Burns 2001). Illness may be more difficult to fight in this population, making prevention even more important. This age group often works with adult cattle and young calves and there are many zoonotic diseases that this population should be aware of. Listeriosis, brucellosis, salmonellosis, Q fever, tularemia, botulism, staphylococcus and streptococcus infections, *E. coli*, salmonellosis, cryptosporidiosis, leptospirosis, ringworm, and the most serious- rabies are all diseases that adult cattle could pass to the dairy workers and/or their families. There are ways to prevent such infections, such as wearing personal protective equipment (gloves, masks, rectal sleeves, waterproof gear, coveralls, boots and others) in situations that may predispose them to exposure. Calvings, abortions, rectal or vaginal palpation, artificial insemination, milking infected animals, passing esophageal tubes or balling gloves, doing an oral exam, necropsies, and handling vaccines or antimicrobials are situations that may cause abrasion of the dairy producer's skin or expose their mucous membranes and they should protect themselves.

Other at-risk clients and their employees may include: children under the age of five, pregnant women, and immune compromised individuals. While the most profound immune suppression is caused by HIV/AIDS, other diseases and conditions that can compromise the immune system include tuberculosis, bone marrow or organ transplants, radiation, chemotherapy or chronic corticosteroid therapy, chronic renal failure, or implanted medical devices (pacemakers, defibrillators, artificial heart valves, artificial knee or hip joints). Persons with diabetes, alcoholism with liver cirrhosis, malnutrition or autoimmune diseases, splenectomy patients, and those on long-term hemodialysis also have compromised immune systems. It is important to note that some of these conditions or diseases may have a social stigma, making it difficult for a client or their employees to share their personal health information. This again makes it vital for veterinarians to educate their clients and their employees about zoonotic diseases.

Children are the future of farming and are a part of many dairy operations in the United States. It is important to understand what our young farmers may be at risk for. Children under the age of five have naïve immune systems, just like neonatal calves. There are many pathogens on a farm, some of which are zoonotic, so educating children and their parents about their risks and how to protect them is essential. One of the tasks on a dairy farm that often falls to the responsibility of young children is calf chores. Feeding, watering, and bedding the calves is something kids are able to do without much supervision and gives them a sense of pride in helping out. It is important to remember what the *E. coli* example in the beginning of this presentation illustrated- children can succumb to disease if exposed. Children who feed neonatal calves should be taught proper hygiene. Things like washing hands before and after feeding the calves, wearing gloves if possible while feeding, and never eating or playing around the calf hutches. They should have designated calf chore clothing and it should be taken off immediately after taking caring for the calves and put in a proper area so younger siblings do not contact it. Over time, children's immunity will build up to many pathogens, but some will always remain a zoonotic disease threat (*E. coli*, salmonellosis, cryptosporidiosis, leptosporosis, ringworm, and the most serious- rabies). Just like the petting zoo example, appropriate signage, hand washing stations for younger people and education about the risks are vital to keeping kids safe from disease.

Regardless of age, certain biological agents used for animals can pose a risk to those handling them. Oxytocin and prostaglandins have detrimental effects on pregnancy and should never be handled by pregnant women. Other products may have toxic potential if accidentally injected or absorbed via mucous membranes (eg. the sedative detomidine, brucellosis vaccine). These

items should be properly identified and precautions should be taken when handling these agents, such as:

- Storing products in a cabinet or refrigerator designed for that purpose. Food for human consumption should never be stored with biologicals.
- Injection needle caps should never be removed by grasping with the mouth.
- Hands should be washed after handling any biologicals.

Proper and frequent hand washing is the best way to prevent many zoonotic diseases. The following hand washing technique is recommended:

- Wet hands;
- Apply soap and rub hands together for at least 15 seconds;
- Rinse with water; and then
- Dry hands with a single-use, disposable towel (using a multi-use towel can spread disease between individuals).

Hands should be washed immediately after handling sick animals, after coming in contact with feces or urine from animals, after using the restroom, and prior to eating to minimize the risk of zoonotic disease. Practicing and teaching these techniques can help protect the veterinarian, staff, and clients from unnecessary exposure.

Another consideration on today's dairy farm is the immigrant worker. Some farms sponsor immigrants for 6 month and 1 year internship experiences, while others employ permanent immigrant workers. Diseases prevalent in some of these countries could predispose these workers to infection with a zoonotic disease. The communication barrier may increase their risk of exposure, so working with knowledgeable translators and ensuring proper medical care will keep this at risk population safe and continue their employment on the farm.

Studies show that veterinarians are the most knowledgeable and the expected purveyors of information on zoonotic disease. Studies also show that immune compromised individuals are not offered adequate information about zoonoses prevention, either from their physicians or veterinarians and may not be as comfortable discussing their immune status with their veterinarian. Physicians and veterinarians alike must share in the responsibility of education about zoonotic disease.

While the possibility of exposure and transmission of zoonotic diseases from animals to people cannot be totally eliminated, it can be minimized. By providing immune compromised clients with correct and up to date zoonotic information, we can encourage them to keep their animals healthy and minimize exposure. This can be accomplished through:

- Making producers aware that information is available to them if they or family members are immune compromised,
  - Through conversations on farm, clinic newsletters, extension or outreach to local community organizations;
- Making dairy producers aware that immune status can be affected by many conditions;

- Speaking with immune compromised clients regarding animal handling guidelines and recommendations;
- Providing a handout/brochure on zoonoses information with web links for further information.

Routes of Transmission

Pathogenic agents can be spread from animal to animal, or animal to human, through a variety of transmission routes. Animals or humans can acquire disease causing agents through inhalation or aerosolization, oral consumption, direct contact, via fomites or vectors. Dairy cattle are often exposed to a variety of pathogens due to the environment in which they are housed and milked. Many disease agents can survive for extended periods of time in soil or other organic material. While not a route of transmission, environmental contamination must always be taken into consideration. We will discuss each of these routes and recommend control strategies to manage disease risk in the coming sections.

Aerosol

The ability of pathogens to survive and be transmitted in the air varies by organism as well as other factors such as season, temperature, humidity and wind speed. However, the greater the distance of separation between a carrier and a susceptible animal the less likely transmission will occur. Direct contact between an infectious and susceptible animal will result in exposure, while pathogen concentration in the air decreases exponentially with distance. Therefore, increasing distance between wildlife, animals from other operations, and newly introduced animals should minimize exposure by the aerosol route.

Appropriate ventilation is extremely important in reducing airborne pathogen transmission. This becomes most important in the calf housing areas. Whether calves are housed in individual hutches, a greenhouse barn, or a confinement facility, adequate ventilation, moisture control, and temperature regulation are essential for healthy animals. There are recommended guidelines regarding the number of air exchanges in confinement facilities depending on the buildings length, width, height, desired temperature, type of ventilation system and the number of animals. It is recommended to maintain room air relative humidity at 50-75% to minimize condensation, dust and airborne bacteria. (MWPS 1985)

Adult dairy cattle housed indoors also require appropriate ventilation to minimize airborne disease exposure year round and to minimize heat stress during certain times of the year. Times of congregation, such as moving cattle to the holding pen prior to milking, within the parlor, and around feed bunks and waterers if cattle are housed outdoors, can influence the airborne pathogen load. Cattle should be moved slowly so as not to increase respiratory rate which could induce coughing and expiration of pathogens from infected animals. Excitement and stress should be held to a minimum so as to minimize airborne disease transmission.

Extension services, agricultural engineers and Midwest Plan Service have specific information available for ventilation needs for various types of dairy facilities.

Oral

Oral transmission can occur through consumption of contaminated feed, water, or the environment that cattle may contact with their mouth. Items such as equipment, feed bunks, water troughs, fencing and other objects that they can lick; contaminated mineral, sodium

bicarbonate, and salt feeders; oral drenching equipment, esophageal tubes, and numerous other objects found on a dairy operation can transmit pathogens orally.

Milk/Colostrum

The first feedstuff consumed by a calf should be colostrum. Milk and colostrum are very effective means of transmitting disease organisms (*S. aureus*, Johne's disease, *M. bovis*, BVD and *Salmonella* spp.) from dam to calf and from the environment to calf (via soiled or fecal-contaminated teats and udder). One might consider the optimum BRM plan to include testing cows for diseases of concern (Johne's, salmonellosis, bovine leukosis virus and others), and using colostrum from test negative animals. Single source, dam to calf colostrum is generally considered the preferred feed source for neonatal calves. An alternative source is sometimes required when a dam is agalactic, has severe mastitis in multiple quarters, or is otherwise unable to provide an adequate source of colostrum for her calf. In this case, colostrum should be provided from an older, healthy cow from the same herd. Colostrum from such animals should be collected as aseptically as possible and can be frozen for up to one year without significant deterioration in quality. To store colostrum, use 1 gallon zippered lock baggies. Fill it ¾ full with colostrum and lay it flat to freeze. Each bag should be labeled with the cow's identification number, collection date and any other pertinent information. That way, should an animal test positive for an infectious disease, her colostrum can be removed from the supply. Do not stack colostrum bags in the freezer until they are frozen. Condensation accumulates and the bags will freeze together if stacked too early in the freezing process. The one gallon bags allow for ease of thawing due to their large surface area that can contact warm water in a bucket. The bag also stores enough colostrum for the first feeding to a newborn calf.

Pasteurization of colostrum is becoming more common so as to decrease the risk of pathogen spread to newborn calves. The benefit of minimizing the risk of disease spread versus the destruction of proteins, specifically immune globulins, needs to be weighed for each herd. Research is ongoing for ideal time and temperature.

Post colostrum feeding, calves should then be fed pasteurized whole milk or high quality milk replacer to prevent transmission of diseases. If milk is pasteurized, time and temperature of the batch should be monitored on a frequent basis to ensure proper destruction of organisms from the lactating cows. Milk replacer should be stored in an air-tight container so as to keep out environmental contaminants and to minimize risk of oral spread of disease upon next feeding. The containers used to feed milk (see fomites) can be an excellent source of oral contamination (*S. aureus, M. avium paratuberculosis, Salmonella* spp.) if not rinsed and cleaned properly between uses.

Feedstuffs

Control of the feed sources and quality is just as important for the remainder of the herd. All feeds on a dairy should be evaluated for their risk of introducing and/or transmitting disease. This includes harvested feeds (silage, hay and grain), purchased protein sources, mineral mixes, and other supplements. Feeds purchased from other sources should be accompanied by an acceptable quality assurance program and documentation. This should verify that reasonable measures have been taken to protect the feed from contamination with potential disease-causing material, including ruminant derived protein. If a contamination is suspected, a representative sample of the feed should be collected and frozen for diagnostics.

The best feed can become a threat if not handled and stored correctly. This typically means preventing access and contamination from **any animals,** including wildlife, birds, vermin and scavengers, as well as dogs, cats, cattle and other livestock which may urinate, defecate or otherwise introduce disease. For certain feedstuffs, like silage and grain, it may also mean proper protection from weather (to prevent spoilage and mycotoxin development), as well as special efforts in ensiling and/or processing to ensure appropriate conditions (anaerobic, low pH, etc.) are achieved to protect the feed from listeriosis, clostridium, and mycotoxin proliferation. During harvest, it is essential that wildlife carcasses are not ensiled because they carry the risk of contaminating the feed with botulinum toxin. Spilled feeds should be frequently cleaned up and disposed of, particularly adjacent to storage or feeding areas. Spilled feed attracts rodents, wildlife, fosters spoilage, and serves as breeding ground for other pests. In most cases, stored dry commodities should be used in a first-in, first-out manner, and new feed should not be added to or poured on top of older feed. Similar diligence is needed in utilizing the feed. For silage stored in trenches, the face must be maintained appropriately by removing an adequate amount each day to prevent spoilage (this is generally recommended to be 6-12 inches off of the entire face each day; however, this will vary with weather conditions).

Feed bunk and manger management is essential to ensure good quality feed for optimal dry matter intake. Adequate nutrition is required for an animal to remain healthy. In order to meet the high intake demands of lactating animals, feed should be made available throughout the day. Therefore a large amount of feed is delivered once or twice a day. It is important in these situations to push up feed frequently to encourage consumption and remove old feed, especially if it has been contaminated. Piling new feed on top of old presents an ideal environment for proliferation of spoilage and disease organisms during hot weather. Scraping feed bunks and mangers to remove all old feed should be done on a regular basis to ensure the spoiled feed does not get consumed or contaminates fresh feed piled on top. From a disease standpoint, if feed is allowed to spoil, it serves as a great nutrient source for microorganisms to proliferate. Organisms, such as *Listeria monocytogenes* and *Clostridium perfringens*, and mycotoxins can grow in old, spoiled feed and expose the cows upon consumption. Accumulation of old feed also serves as a breeding ground for flies and other pests which can spread disease (discussed more in-depth in vector section). Concrete feed bunks deteriorate over time and cracks and holes serve as an incubator of organisms if they get packed with feed. Things such as plastic bunk liners, polyethylene coating, and ceramic tiles can be used over the concrete to keep the surface smooth. It minimizes spoilage and exposure to oral consumption of disease pathogens.

Often feed is offered to cattle on the ground at the same level where people walk and drive. At no time should anyone walk or drive through feed. Feces, urine and saliva can subsequently contaminate the feed and cause oral consumption of disease causing organisms. Man-passes (people-passes) could be used so that personnel are able to enter the cow's pen without climbing through the feed bunk or over fences. Again, the possibility of wildlife or rodents introducing disease must be recognized, and access to feed bunks or stored feed areas should be minimized and eliminated if possible.

For animals on pasture, efforts to protect them from oral consumption of disease organisms include avoiding fertilization with high risk materials (non-composted manure, possibly poultry litter), frequently dragging the fields to break up fecal pats in drier climates (organisms die more rapidly when exposed to heat, sunlight and wind), and avoiding overgrazing, which forces

animals to graze closer to the ground and nearer to fecal pats. Cattle should be kept away from pastures fertilized with high risk materials for as long as possible.

Supplemental hay feeding can present a unique challenge for disease control. Use of hay rings or similar feeding methods congregates the animals which can lead to a contaminated environment. Dispersing the hay (scattering flakes or unrolling large round bales) reduces this, but often leads to contamination of the hay when animals lay on it or soil it. Regardless of which method is used, frequent changing of the feeding area, appropriate grouping of age cohorts and minimized stocking density will be beneficial. Similar principles apply to wooden feed bunks- frequent movement and minimal feed wastage are ideal to avoid spoilage. These should be cleaned out frequently to avoid feed buildup and bunk liners used to avoid accumulation in the cracks.

Water

Water consumption is necessary for life and milk production. Milk is composed of 86% water, so offering a fresh, clean source is essential to milk production. Animals fed in confinement or tie-stall/stanchion barns should have water available in troughs or drinking cups throughout the day. Waterers can serve as a risk factor for disease if not maintained and cleaned properly. Waterers should be monitored daily for functionality and cleaned when organic debris begins to accumulate. In trough type automatic waterers, a rail should be installed two feet above the top rim of the waterer. This will minimize cows from standing or defecating in the trough while allowing their heads to enter freely and consume water. Young calves should be offered fresh water throughout the day and a rail can be installed at 18 inches (or lower for younger calves) above their automatic water trough to prevent entry and defecation. Individual water buckets should be cleaned as described in the fomite section to avoid accumulation of organic debris.

Natural sources (creek, pond or cistern) are often used in pasture situations because of convenience and reduced expense. Generally speaking, troughs are preferred because of quality control and less wildlife/other animal contamination. Natural water sources are at risk from contamination by wildlife, other livestock operations (leptospirosis, among other diseases) and other natural threats (blue-green algae, for example). The source should be protected as much as possible and monitored for problems. Regardless of the water source, dairy producers should consider testing water quality every six months, and more often if there is a problem. Monitoring coliform counts, nitrates and nitrites, sediment, hardness, and other minerals can be helpful to prevent disease and maximize milk production.

If cattle drink directly from ponds, producers should consider fencing the pond off and providing limited access. This access area can then be protected by concrete or large rock to prevent soil erosion into the pond, and limit runoff into the water. By preventing animals from entering the pond, fecal and urine contamination is greatly reduced, as is the risk of cows getting mastitis. Similar measures can be taken to prevent contaminating streams, although it may be harder, due to the length of the stream. Streams pose an additional disease threat, due to the potential contamination from upstream. Producers should strongly consider restricting access of cattle to streams.

Manure and Waste Management

Because many of the diseases contracted through the oral route (such as salmonellosis, campylobacteriosis and giardiasis) originate from fecal contamination, waste management is vitally important in controlling these pathogens. Due to their intake, dairy animals deposit

between 2.0 to 2.4 cubic feet (115 pounds; 14 gallons) of manure a day (Environmental Protection Agency, Purdue University, 2004). This requires frequent waste removal, once to several times per day depending on the housing, weather conditions (hot weather induces drinking and more frequent urination) and animal density. It should then be transported to a designated storage or disposal area, out of contact with animals. This should be done with **designated equipment**. This equipment should not be used for other purposes, such as feed delivery, bedding, crop handling, etc.

For larger operations, requirements for waste handling are usually determined by state or federal environmental regulations. These regulate when and where waste can be spread to minimize environmental impact, as well as storage and transportation. Our focus is only on possible disease transmission; local, state and federal regulations will provide much more specific guidelines, and should be understood and followed.

If manure is to be stored, it should be kept in a well constructed lagoon, with adequate capacity to handle large precipitation without overflow. The location should be such that, should an overflow occur, it would not expose animals to discharge. If this is not possible, the most susceptible animals should be protected from exposure. Composting is considered by some to be a beneficial and viable method of handling manure. The advantages include a great reduction in volume and water content, and a significant reduction in pathogen levels. Disadvantages include the time required for completion of the process, the equipment and labor demands, and loss of nutrients. If waste is not composted, producers should be cautious in what locations and at what times manure is applied.

Cropland can generally be considered a minimal risk of sustaining pathogens if the waste is applied early in the growing season. However, for some persistent pathogens like *M. avium* subspecies *paratuberculosis* (Johne's), as well as protozoal oocysts (such as *Eimeria* spp.) and helminth eggs, a single growing season is not sufficient to eliminate infectivity. Pastures are more of a risk, because there is no further processing to kill the organisms (like fermenting silage, drying hay, etc.). The safest recommendation would be to not spread manure on pastures in which susceptible animals would be placed (this of course will vary by operation, what animals are present, and what diseases are of concern). Similar or even greater cautions should be exercised in accepting manure or organic waste onto the farm from another source. Producers must recognize that they may be unwittingly permitting exposure of their animals to waste from other farms by streams and waterways or direct runoff. Such exposure may be transient (such as following a hard rain), but no less significant. A thorough examination of the operation's perimeter is required to assess where such points of access may occur and how they can be controlled.

The survival of pathogens within manure depends on a variety of factors including sunlight, drying, freezing/thawing cycles, high temperature, high/low pH, exposure to oxygen, ammonia concentration numbers, types of pathogen present and the adsorption of the pathogen to soil. Generally speaking, the risk of spreading disease will be lowered by exposing the waste material to environmental conditions. The most important means of accomplishing this is to adequately disperse the material. Dragging dry lots and pastures to break up and disperse fecal pats is an effective practice in drier climates. But similar to spreading manure for fertilizer, adequate time should be permitted between distributing the manure and returning animals to the lot or pasture. This ensures that the organisms are exposed to the damaging environmental conditions listed above.

Fecal Contamination from Other Species

Feces from other species can also serve to transmit disease to cattle. While it is virtually impossible to exclude wildlife from a pasture, every effort should be made to prevent access of animals to stored feed and feeding areas. Birds and vermin are quite effective at transmitting disease and are common in feed storage areas, confinement facilities and barns. Producers should recognize that even domestic animals pose risks because dogs, cats, goats, sheep and horses can all introduce disease to cattle.

Direct Contact

Direct contact requires the presence of an agent or organism in the environment or within an infected animal. A susceptible animal becomes exposed when the agent directly touches open wounds, mucous membranes, or the skin through saliva, nose-to-nose contact, rubbing, or biting. Neonatal calves should be managed in such a way to limit methods of direct contact, either with their dams or cohorts, to minimize disease risk. See the replacement section in herd characteristics for specific details. One of the most important efforts to reduce transmission via direct contact in adult cows is the isolation of sick or newly introduced animals. Ideally, a dedicated area or pen for isolation and separate milking facilities will help decrease the risk of diseases through direct contact. At the minimum, a dedicated pen within the operation is mandatory. Animals should be housed in this pen until they clear testing procedures or have had sufficient enough time to allow a disease pathogen to manifest itself. Additionally, incoming animals should be fed last, treated last, and milked last and all equipment should be cleaned and disinfected afterwards (see Fomite transmission for specific details on managing equipment).

Unfortunately, not all infected animals show signs of disease. In order to minimize transmission from carrier animals, fence line contact should be limited, both to animals from other operations (neighboring farms) and also to animals from different production groups on the same operation. Additionally, stocking density should be kept at the lowest acceptable level to minimize animal stress.

Fomites play a major role in transmission of direct contact diseases. It is imperative that producers recognize that virtually anything that contacts an infected animal then a susceptible animal can transmit that infection.

Reproductive

For the purposes of this document, reproductive transmission will encompass those diseases spread through venereal and in-utero routes. Venereal transmission, a type of direct contact, is the spread of pathogenic agents from animal-to-animal through coitus. In-utero transmission, another type of direct contact, is the spread of pathogenic agents from dam to offspring during gestation. Vaccination programs can be put in place for some of these reproductive diseases, but should only serve as an addition to proper BRM measures.

Disease risks associated with coitus vary depending on the type of reproductive service. See page 22 for management recommendations related to reproduction.

Vertical or in-utero transmission often involves a chronically infected dam; however, it may also relate to exposure of the dam during a critical stage of gestation. Test and cull strategies should be considered for certain vertically transmitted diseases. While whole-herd testing may be cost prohibitive, producers should be encouraged to test suspect animals, such as repeat or

"hard" breeders, cows that show erratic estrous cycles, and animals that abort. Testing the dam and offspring of cows that are diagnosed with a disease that can be transmitted vertically (BLV, BVD, neospora among others) should also be considered. This demands maintenance of complete and current records to facilitate identifying dams and offspring of affected animals.

Additional control measures relate to protection of the dam at critical stages of pregnancy. This varies by pathogen and generally necessitates the classification of pregnant animals as a susceptible population on dairy operations.

Fomites

Virtually any inanimate object can serve as a fomite and carry a pathogen from one susceptible animal to another. Fomite transmission often involves a secondary route of transmission such as oral or direct contact for the pathogen to enter the host. Humans often play a principle role in facilitating fomite exposure, which is referred to as iatrogenic (see below). Therefore, in order to have a successful BRM plan for the all routes of transmission, it is vitally important that all potential fomites be recognized and handled appropriately.

There are many fomites on a dairy farm in each of the life stages listed above. We will start by discussing lactating animals and the biological risks associated with fomites.

Milking Equipment

Milking equipment serves as one of the most significant fomites on a farm. Every adult cow will come in contact with the milking claw and liners two, three, even four times per day. It is essential that this equipment is washed, sanitized and disinfected preferably between every milking, or at a minimum, once every 24 hours. This functions to remove organic debris, disease pathogens, and milk from the claw and pipeline. Any known diseased animals, namely those with mastitis, should be milked last in a string so that the equipment can be cleaned and sanitized afterwards. Since many of the mastitis organisms are directly contagious to other animals, any milk residue that remains in the claw, liners or hoses, runs the risk of exposure to the next animal. There are various methods by which milking equipment can be sanitized between animals. Some facilities have back flush systems directly installed. These function by flushing water through the individual milking claw and hoses to remove the milk residue left behind from each animal. Another method commonly used is a rinse bucket. Used properly, they can remove much of the milk residue and pathogens left in the milking claw. It does not reach the milk hoses however. Specifically, a stainless steel bucket with warm water and a sanitizer or disinfectant mixed at a concentration that will eliminate the target organisms on that facility can be used. Upon completion of milking an infected animal, the claw is removed from the automatic take-off pulley, held upside down and allowed to drain as much milk out as possible. It can then be dipped into the bucket with sanitizer/disinfectant solution and allowed to have appropriate contact time. The unit should be placed in the solution at an angle so as to allow contact with the inside of the liners. This will remove residue and destroy pathogens. If the unit is placed straight in to the solution, it will act like an inverted glass; not allowing sanitizing solution to penetrate. The claw is then lifted out, allowed to drain and then rinsed in a bucket of warm water to remove any residue of sanitizer/disinfectant. Again, it is allowed to drain and can be used on the next cow. Ideally, the sanitizer/disinfectant bucket should only be used once. As organic matter (milk) builds up in the bucket, the sanitizer/disinfectant becomes less effective. This can lead to a false sense of security and actually do more harm than good.

Other fomites commonly found in a milking parlor are teat dip cups. These have the purpose of holding a solution that is used on the teats prior to milking to help disinfect and post milking to help protect the teat end from organism penetration and to moisturize the teat skin. When properly used, they do an excellent job of preparing the teat to be milked in a sanitary manner and protecting from disease entry post milking. Organic buildup in the cups (feces, milk, urine, bedding) deactivates the chemicals and may actually increase exposure to disease causing organisms. Teat dip cups must be monitored for contamination and the solution dumped down the drain, the cup promptly rinsed, washed with detergent and warm water, and then refilled with fresh dip before using on another animal. Never dump the remaining dip back into the original container- too big of a risk of contamination. After each milking, the teat dip cups should all undergo a cleaning/washing procedure. Again, the "solution to pollution is dilution" and by removing organic material and using clean teat dip cups each milking, pathogen load is decreased.

Towels used to wipe teats should be single use to minimize disease exposure and spread. If they are washable, be sure to not overload the washing machine, add detergent and/or bleach to the water before loading to get even dispersal of the solution, use hot water, and ensure adequate time for the cycle to run. Washable towels must be dried completely before the next use. All three elements of hot water, detergent and/or bleach and drying are crucial. A short cut of one step can compromise the entire procedure. Piled up wet towels can harbor and proliferate organisms if not dried completely. Dry towels should be stored in an area to prevent environmental contamination until they are used.

Calf Equipment

Some fomites that need to have special management for calves include esophageal feeders, bottles, buckets, clothing worn by feeders, hutches, others. If calves won't nurse or need oral electrolytes, esophageal feeders can be used. This equipment should be thoroughly washed with warm soapy water, rinsed, then disinfected and hung up to dry with a plastic garbage bag thrown over it to protect it from environmental contamination.

Management recommendations pertaining to milk bottles, buckets, and feeder's clothing can be found on pages 18 and 19.

Calf pens or hutches must be cleaned, sanitized and disinfected between introducing another calf to minimize disease spread. The ground underneath the calf hutch has the potential to harbor pathogens; organic bedding should be removed and the ground allowed to sit idle with sunlight exposure for as long as possible.

Treatment Equipment

All equipment used for treatment - halters, balling guns, esophageal tubes, drenching equipment, needles, syringes, IV lines, oral and vaginal speculums, head catches, and chutes should be cleaned and disinfected. Suspect objects would include anything that could potentially become contaminated with blood, saliva, nasal secretions, urine, feces, or come in direct contact with infected skin or tissues. Some items may need to be disposed of rather than re-used due to the inherent challenges to proper disinfection. Once they are dried, storing these clean items in drawers, plastic bags, or covered up will help to protect them from environmental contamination. Another management strategy to minimize the spread of disease is to work with sick animals only after all healthy animals have been treated.

Other Equipment

Waterers and drinking cups can serve as a fomite if they are not maintained properly. Organic debris can build up over time and harbor disease causing organisms (*Salmonella* sp., *Leptospira* sp.). Waterers should be monitored daily for functionality and cleaned weekly or more often if debris accumulates. See oral transmission for more detail on water quality.

Vehicles, tractors and implements, four wheelers and other machinery often are used in multiple settings within an operation. This presents a very real risk of spreading disease, not only by introducing contamination from one environment to another, but also because cattle are curious animals. It is quite common for cattle to smell, lick and rub against these items, particularly if other animals have done so previously. To reduce the disease risk from these fomites they should be restricted to designated areas, kept clean, and kept from contact with animals to the greatest extent possible. Vehicles frequently in close contact with animals should be restricted to on farm use only or thoroughly cleaned and sanitized when used off of the premises.

Even immovable objects present a potential for spreading disease when naïve animals have contact with them. Examples would include fences, gates, panels, and buildings. It is best to designate areas for each group of animals and limit access of different age groups of animals to a given area.

Contaminated clothing, shoes, or even skin on personnel are additional examples of fomites. For certain zoonotic diseases humans can actually be infected with the organism and shed it into the environment. While this does not fit the strict definition of fomite, it nevertheless requires that people follow proper hygiene and biosecurity standards. This would include at the very least, changing clothes after being in a contaminated environment, and avoiding contact with animals after being in high risk situations (such as travel to countries with foreign animal diseases).

Certain objects have the potential to introduce and spread a disease on the dairy operation. Items of concern would include vehicles and equipment (including portable chutes, tractors and implements, livestock trailers- see traffic below), feedstuffs (possibly refuse or byproducts- see oral, feed), animal husbandry items (needles, syringes, dehorners, halters, etc.), and anything else that has come in contact with infected livestock.

Iatrogenic

Iatrogenic transmission is the unintentional transmission of disease by a medical professional using a contaminated fomite. Since many medical procedures are done on farm by dairy employees, it is imperative that producers recognize that virtually any inanimate object that contacts an infected animal, followed by a susceptible animal can transmit that infection. The "Fomites" section presented previously should be reviewed and considered in relation to iatrogenic transmission of diseases.

Use of products from a multi-dose source can present a risk of iatrogenic spread of disease as well. Producers should be cautious to use aseptic technique in drawing medication from multi-dose bottles, such as oxytocin in the parlor. The most effective way to eliminate disease spread between animals is to use a new needle and syringe every time an injection has to be given. For example, only a new needle should be injected into a product for a desired dose. Should an additional dose be needed, another clean needle and syringe should be used. This adds

expense but decreases disease risk, so the cost/benefit needs to be evaluated for each operation. Caution must be exercised with the type of product used. There is always a chance of human exposure to the product if gloves and eye protection are not used. Some products may have infectious potential if accidentally injected or adsorbed via the mucous membranes of a person.

Many of the products licensed for use on today's dairy farm are single use items (bST, mastitis tubes, dry cow tubes) and are intended to be just that- single use. The manufacturers of these products recognize the disease risk if a needle has blood contact. Due to the shear nature of why a mastitis tube would be used, contagious organisms are involved and the product must only be used once, and only in one quarter, then properly disposed. The person administering the treatment should wear gloves, wash their gloved hands thoroughly with soap and warm water after treating the infected teat(s) and dispose of their gloves before handling another animal. The alcohol pad used to clean the teat end should also be used only once (on only one teat) and disposed of properly so that another animal does not come into contact with it. Following treatment, the teat should be dipped with a standard post-dip solution to prevent further infection. Proper medication handling is critical as antibiotics can support growth of some organisms, and can result in serious complications when contaminated products are administered parenterally.

The presence of carrier animals in the herd presents an ongoing threat to further spread of disease. A well designed and carefully implemented BRM plan can virtually eliminate all risk of iatrogenic transmission. Some dairy producers are reluctant to commit to the more tedious and expensive components of such a plan, such as a new needle or rectal palpation sleeve for each animal. In these situations, it may be advisable to test for the various diseases of interest and treat or cull carrier animal(s). Alternatively, physically separating them, and working with susceptible animals as a separate group with appropriate disinfection protocols will help limit the spread of certain diseases.

Traffic

Unique and specific risks are presented by vehicle traffic movement on a farm. In the true sense of BRM, the major risk of these activities would be related to their potential as fomites. However, because of the unique challenges associated with controlling traffic and the very real risk that it poses, it should receive additional scrutiny beyond what was previously discussed. The "Fomite" section dealt principally with traffic on the farm, from one group of animals, or area, to another. This section will discuss the risks associated with traffic introducing diseases onto the farm.

Vehicles can transport organisms and deliver them to susceptible animals in a short time. The first step in controlling the threats posed by vehicle traffic is to understand who brings vehicles onto the operation, what vehicles, where they have been, where on the farm they go, why, and how often. This scrutiny should be applied equally to all people, including farm owners and family members, employees, milk truck drivers, veterinarians, renderers, delivery and service vehicles and visitors. The type of vehicle should be noted, from cars and trucks to tractors and other equipment, trailers, portable chutes and any other mobile object that is brought onto the property. An effective means of doing this is to create a visitors log, where everyone is required to sign in and provide the above information. Additionally, all visitors should be requested to contact the operator prior to their arrival and make arrangements to have someone meet them at the appropriate time. This limits the need for people to wander around

the farm searching for an office or personnel. It also makes it easier to identify uninvited or unapproved people who may pose a threat to livestock health.

The simplest and most effective vehicle control measure is to have a designated parking area on the perimeter of the farm and request that all visitors be restricted to use of on farm vehicles. This is not always possible, as in the case of milk truck drivers, feed deliveries, veterinarians, and milking equipment service and repair personnel. Standard operating procedures and posted signage should be made available so these people follow proper protocols on the dairy facility to minimize disease spread. If these visitors are required to drive onto the facility, their vehicles should be inspected for cleanliness and ensure their drive path does not have direct animal contact. In the case of feed trucks, deliveries should be made as infrequently as possible. The farm may request to be the first delivery of the day but this may not be practical or acceptable for the feed company. If it is a shared drive path with on-farm vehicles, and the risk exists for introducing a new disease to the farm, a wash down facility and/or a tire washing area with an appropriate disinfectant should be made available and its use strictly enforced. The area should have adequate drainage so as not to contaminate animal areas. In other cases, the "target" may best be brought to the visitor. This could include having a limited access area (again on the perimeter of the property), where equipment can be left for servicing, dead stock can be taken for pick-up (preferably out of sight from main roadways and properties as well as away from all other farm traffic), and pallets of bagged feed or supplies can be left in protected structures.

Animal delivery/load out facilities should be placed in a designated area on the perimeter of the farm. These areas should be well maintained, with gravel, asphalt or concrete surfaces. Adequate drainage away from the farm should be provided to ensure all potential contamination is kept away from animal areas.

Implementation of some of these ideas may be beyond the commitment most producers are willing to make. Potential or perceived obstacles, including facility redesign, new construction, and perceived inconvenience to visitors may discourage many producers. However, for some high traffic- high risk operations, or for producers with extremely valuable genetics, all of these options should be considered. Furthermore, cost and convenience should never serve as an excuse to compromise the BRM plan of an operation. No one should be permitted to drive a soiled vehicle into an animal area. It is not unreasonable to request visitors maintain a sanitary vehicle or park off farm. Similarly, it is not unreasonable to insist that visitors do not drive through areas of concern, such as confinement barns, calf hutch areas, feed areas, water sources, and pastures.

Vector

Diseases can be transmitted by vectors either mechanically or biologically. Mechanical transmission means that the disease agent does not replicate or develop in/on the vector; it is simply transported by the vector from the environment (contaminated feces, feed) or one animal (nasal and ocular secretions) to another. Biological transmission occurs when the vector (mosquitoes, ticks, lice, mites) uptakes the agent, usually through a blood meal from an infected animal, replicates and/or develops it, and then regurgitates the pathogen onto or injects it into a susceptible animal. The prevalence of vector-borne diseases (such as anaplasmosis, bluetongue or vesicular stomatitis virus) is dependent upon the prevalence of the disease agent, distribution of the vector, their abundance, life expectancy, feeding habits and ability to support the pathogens' existence in their body. The ideal method to prevent vector

transmission is eliminating the insect and/or the disease agent from the area. When this is not feasible, other methods such as separating or limiting exposure of the host from the vector and reducing the vector's breeding areas can be effective.

Eliminating the Insect

Chemical insecticides are frequently used to control insects, but this is invariably ineffective as a sole measure. On a dairy operation, the risk of chemical residues in milk is a huge concern. If the insecticide product is not labeled for use in lactating cattle or on a dairy farm, it should not be used. Residual sprays cannot be used in the milking parlor. If chemical components are used, it is imperative that the manufacturer's instructions be followed. Inappropriate use can present a hazard to the animals and/or environment, can greatly reduce efficacy (using a water based product just prior to rain on animals housed outdoors), and lead to insect resistance (not removing impregnated ear tags from heifers when their efficacy is reduced).

Methods of killing insects include:

- Direct treatment of cattle with pour-ons, ear tags or face rubs
  - To target face flies, one ear tag in each ear is recommended
  - Effective but short-lived duration
  - Insect resistance becoming a problem
- Spraying premises with knockdown insecticides
  - Effective in smaller areas; inefficient in larger areas
  - Must be used the same day they are mixed up
  - Duration short-lived (1-2 hour action)
  - Effectiveness dependent upon weather conditions (target air temperature between 65-90^{o}F for best results)
- Spraying calf hutches/barns with residual sprays
  - Remain active for several days
  - Apply to shaded areas only as ultraviolet light breaks down chemicals
  - Rain will wash away spray so must be reapplied
- Biological control such as parasitic wasps feed on fly larvae, or birds that eat insects
  - Effective but requires repeated introduction of control organism
  - Birds present their own biological disease risks such as spreading salmonellosis, and this should be considered if this option is chosen
  - If used in conjunction with sprays, the parasitic insect may be killed

Separating Host/Vector

Separation of host and vector is needed when a specific region is heavily populated with insects and premise treatment is not practical. This may be necessary to minimize exposure to standing water where mosquitoes lay their eggs, streams where black flies reproduce, and wooded areas heavily infested with ticks. In these cases, the most effective measure may be to

fence off these regions during principle insect seasons or confine animals to a building that can be insect-proofed or sprayed with an approved insecticide.

In some cases, the presence of carrier animals in the herd presents an ongoing threat to further spread, regardless of how effectively vector control is implemented. In these situations, it may be advisable to test for the various diseases of interest and treat or cull carrier animal(s). Alternatively, physically separating them from susceptible animals has shown some success in limiting spread of certain diseases (BLV, for example). Vaccination of susceptible animals can also be practiced in some cases, but this is generally considered as a last resort.

Breeding Area Control

There are various diseases spread through vectors to cattle (see handout) and each insect has a unique lifecycle that needs to be understood in order to implement specific control measures. This is not an all inclusive list, but rather gives a starting point for control strategies. Most insects can be controlled by:

- Eliminating standing water, especially wet, muddy areas (mosquitoes)
- Eliminating decaying organic matter weekly (flies)

Wet areas may occur around water and feed troughs, in areas where animals congregate, and in old tires used to hold down the plastic covers on silage piles. Measures to control these include frequent cleaning around water and feed troughs, dragging dry lots to spread out fecal pats in cattle congregation areas, cleaning loafing sheds frequently, using tires that have holes punched in them or are cut in half so the treads are removed, and eliminating standing water from various sources.

Decaying organic matter includes spoiled feed, soiled bedding, open manure piles, dead animals, etc. This is especially important in calf hutches. Prompt removal (at least weekly) of these materials limits the ability of insects to breed and feed on them. Dragging dry lots and pastures to disperse fecal pats also reduces the breeding and development of flies. A similar approach involves the use of insect growth regulators in feed, which prevents maturation of insect eggs laid in fecal pats. This practice can be detrimental to other insect species, including some considered favorable. For best effectiveness, the feed supplement must be fed prior to the presence of flies, which can be difficult to predict. Otherwise you have to play catch up with the eggs laid in fecal pats and it is often not economically worthwhile.

Summary

In summary, there are many routes of disease transmission on a dairy farm. Each has specific management protocols that can be established to minimize disease introduction and spread. It is important to assess a farm, identify areas of risk, and use the suggested management strategies to help prevent challenges in the future.

Risk Communication

Risk communication is a two-way, interactive process that has been occurring throughout the risk assessment between the facility owner, risk assessor (veterinarian), the employees and other interested parties. Information has been collected, the analysis has occurred, and now

information needs to be delivered to those affected by the risk assessment and risk management plan.

One of the major barriers to effective risk communication is inadequate planning and preparation. Before designing an educational program it is important to consider who is best suited to communicate the message, what message will be most effective, and when and where the information should be communicated.

In large operations, the biological risk management plan may be formulated by upper management, and some employees may not understand the importance of the plan. Risk management plans must be understood, supported, and adopted by every employee for effective implementation. Because many employees may not understand disease transmission routes and the chain of events involved in disease spread, this communication can be difficult and employees may not fully appreciate the significance of the measures they are asked to follow.

Characteristics of effective risk communication:

- It must be adapted to meet the needs of the audience. If bilingual information is required, make sure it is provided;
- It should present the important information in more than one way (appeal to both visual and auditory learners);
- Keep sessions focused to a maximum of three main points and 45 minutes maximum;
- Sessions are more valuable if they are timely and the participants can apply the new information immediately;
- Sessions should cover what, when, where, how, by whom, and why;
- Give participants the opportunity to take ownership of the production process and the ramifications of decisions that impact their area. They should be actively engaged in the question at hand so that they, share information, and most importantly provide input so that decisions become a collective agreement.
- Schedule meetings earlier in the day. Meetings at the end of the working day are less effective.

Educational programs that inform employees and other affected individuals of the risk assessment and management plan can take many forms, and may include:

- Face to face/group meetings (one of the best communication forms if the presenter and participants have open dialogue);
- Newsletter, fliers or bulletin;
- Videos, CD's, PowerPoint presentations or web-based instruction;
- Posted signs or information panels placed at key locations on the farm (parlor, milk room, calf feeding area, treatment room);
- Employee questions and suggestions (question/answer board, suggestion box, question period during meetings, etc.);
- Mentoring of new employees by experienced employees;

- Recognition or incentive program that rewards employees when BRM goals are reached (this has been used on some farms focused on lowering their somatic cell count, calf death losses, and heat detection rates).

Educational programs should not be limited to one form. Facility owners may incorporate many of the above mentioned education forms to create a program that fits the needs of their facility.

To help the veterinarian facilitate communication, there are handouts about each of the routes of transmission with various applicable diseases provided on the CD-ROM to educate producers about the risk of zoonotic, endemic and foreign animal diseases. The reports that can be printed based on the answers to the assessment question provide a visual tool to the strengths and weaknesses for the various routes of transmission on a dairy farm. The final report graphs that are generated are meant as a visual aid to illustrate potential areas of action. The various risk factors identified have not been quantified or prioritized. It should not be interpreted as an arbitrary number which is required for a facility or veterinarian to "pass," or even that comparable scores for two different facilities mean they face equal risk. The reports should be used to identify if a particular area seems to represent a disproportionate risk and help track progress over time through continued assessments. The management recommendations are made to minimize circumstances that could potentially result in the spread of infectious diseases.

Proper communication of the risk management plan is of utmost importance for effective infectious disease control. When communication is effective and efficient, disease spread can often be minimized and controlled. However, few management plans are successful if records are not kept or some form of biosecurity audit performed so that progress can be measured. Part of the risk communication process should include helping to ensure that a monitoring system is put in place to measure progress.

Conclusion

Biological risk management is an essential component of keeping any dairy operation as clean and secure as possible. Risk of disease transmission cannot be completely eliminated, but by employing some basic hygienic and biological risk management principles, these risks can be effectively managed and significantly reduced. It may take time to persuade your clients to adopt some of these principles, but the results of your efforts will reflect the efficacy of this program, and others will follow suit in time.